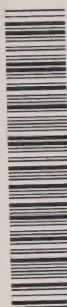



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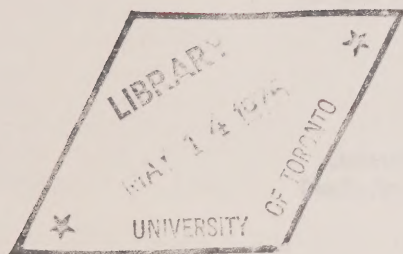
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OF THE CANADIAN POPULATION, 1851-1961

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EXTERNAL MIGRATION AND THE AGE STRUCTURE
OF THE CANADIAN POPULATION, 1851-1961*

by

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The problem

1. For 'closed'¹ populations a high state of development has been reached in the analysis of the demographic determinants of age distributional change. The relevant mathematical analysis has been extensive (for example, see Lotka, 1939; Leslie, 1946; and Lopez, 1961), and results from this analysis are frequently being used in the estimation of vital rates (see, for example, Coale, 1963). In the case of 'closed' populations, extensive statistical measurement of the relative contributions of fertility and mortality to age distributional change seems unnecessary, in view of the clear predominance of fertility (see Coale, 1956).

2. For 'open' populations the analysis of age distributional change is underdeveloped, at least by comparison with the 'closed' - population case mentioned above. As late as 1963 Tabah and Cataldi (1963, p. 683) have noted that:

Dès que les lois de mortalité et de fécondité ne se maintiennent plus constantes, que des échanges migratoires s'effectuent avec l'extérieur, ou que la composition ne reste plus homogène, il devient difficile d'apprécier l'effet qu'on pu produire ces transformations dans la situation observée a un moment donné.

The mathematical analysis for the 'closed' - population case may be extended without great difficulty to the 'open' - population case (Hyrenius, 1959; Stone, 1965a; Rogers, 1966). Thus analogues to many of the important theorems for the 'closed' - population case may be established without too much difficulty. However, when the levels of migration become high, fertility

does not clearly dominate the changes in age distribution (Stone, 1967a). Thus statistical measurement of the relative contributions of demographic processes to age distributional change in 'open' populations becomes a worthwhile exercise, and it is still in its infancy (for examples, see UN, 1956; Tabah and Cataldi, 1963; Stone, 1965b; and Stone, 1967a).

3. Statistical measurement of the relative contributions of the demographic processes to age distributional change is useful in helping to satisfy at least two needs. Firstly, there is the need for more extensive scientific knowledge of the relative importance of the demographic processes (for age distributional change) in a wide variety of situations. Secondly, there is the need in regional development planning for generalizations which policy-makers may use in gauge quickly the likely impact on age distribution stemming from prospective alterations in the demographic processes.

4. This paper is intended to be a small contribution to the accumulation of empirical information about the relative weights of the components of age distributional change in an 'open' population. The paper offers a tentative answer to the following question. 'Suppose Canada had been closed to migration from 1851 to 1961. In what respects and to what extent would its age distribution have differed from that actually observed?' The tentative answer provided here to this question is based on at least two assumptions. Firstly, it is assumed that mortality rate differentials between migrants (international) and non-migrants (at a given age) have a statistically negligible impact on the estimated Canadian survival ratios. Secondly, it is assumed that differentials in child-woman ratios between migrants (international) and non-migrants produce a negligible distortion in the results of the present analysis. The readily available Canadian statistics do not permit an empirical evaluation of these assumptions.

5. The analysis based on the above-mentioned assumptions indicates that net external migration has had just a slight impact on the sex-age structure of the Canadian population. At no census year from 1861 to 1961 did the median age in the census population differ from that of the hypothetically 'closed' population by more than one year. The impact of external migration shows up most sharply in the masculinity ratio. The masculinity ratio of the census population has had marked fluctuations, particularly in the years immediately following prominent immigration waves. Such fluctuations in the masculinity ratio are not shown by hypothetically 'closed' population.

The record of Canadian external migration

6. The Canadian population has grown from a few thousand in 1666 to 18 million in 1961, and throughout this period Canada has been open to external migration. Between 1851 and 1961 Canada received more than eight million immigrants and it lost more than six million emigrants, according to the estimate of Camu, Weeks and Sametz (1964, Table 3.1). This number of immigrants received (eight million) was about one-third the number of births taking place in Canada over the same period (1851-1961).

7. The flow of immigration into Canada has had strong historical fluctuations, as Chart I shows. Relative to size of the Canadian population², the intercensal immigration to Canada has ranged from one per cent in 1931-41 to 25 per cent in 1901-11 (see Chart I), and it exceeded ten per cent² in just five of the 11 decades from 1851 to 1961. The relative volume of emigration ranged from two per cent² in 1931-41 to 18 per cent in 1881-91, and it exceeded 10 per cent in five of the 11 decades from 1851 to 1961.

8. Generally, decennial immigration and emigration have been markedly correlated (see Chart I). As a result the net external migration ratio³ has been quite low in almost all of the decades. Only in 1901-11 has this ratio exceeded 10 per cent.

9. Migration is known to be a process selective of sex and age, and the net external migration to Canada is no exception. Over the decades from 1851 to 1961 males have been predominant over females in the external migration. In the various age groups, net external migration to Canada has been concentrated mainly among persons in the early half of working life. During the 19th century the net external migration was concentrated mainly among persons aged 25-44 at the end of each decade. In the twentieth century the interval of this concentration has been extended slightly to include the age group 20-24 (cf. Keyfitz, 1950, Table 3).

Findings and discussion

10. External migration has had just a slight impact on the age structure of the population of Canada (see Table 1), given the assumptions set forth in paragraph 4 and the method described in the Appendix. Less than one year of age separated the median ages of the census and the hypothetically 'closed' populations of Canada in 1961, even though the hypothetical 'closure' of this population was extended for 11 decades (see the rows marked "EP" in Table 1). At no decennial census year over this period (1861-1961) was the difference between the median ages of these two populations greater than one year of age. The old-age dependency ratio was almost the same for the census and the hypothetically 'closed' populations in 1961. Throughout the 1861-1961 period less than three percentage points separated the old-age dependency ratio for these two populations. Clearly, the major fluctuations in the age structure are not explained by external migration.

11. For 1961 the level of the masculinity ratio in the census population of Canada was very similar to that in the hypothetically 'closed' population (see Table 1). This similarity is observed in most of the census years from 1861 to 1961. However there are a few years (particularly 1911 which followed a massive immigration wave) in which external migration

had a very significant impact on the sex composition. In addition the time series of masculinity ratios for the census population shows marked fluctuations which are absent from the time series for the hypothetically 'closed' population - a differential which partly reflects the impact of external migration.⁴

12. Three factors are probably the most important ones in accounting for the generally slight impact of external migration on the sex-age structure of the Canadian population. The first is the strong trend (downward) and fluctuations in the crude birth rate; which are well reflected by the time series of youth-dependency ratios for the hypothetically 'closed' population (see Table 1). The second factor is very low level of net intercensal migration observed for Canada in most of the decades since 1851 (see Chart 1). This observation is explained by the fact that emigration has gone far to offset the substantial immigration which Canada has had. The third factor, probably much less important than the first two in the Canadian case, is the level of sex-age selectivity in net migration to Canada. Although it has been shown that the net migration to Canada has been markedly selective with respect to sex and age (see Keyfitz, 1950), the degree of selectivity (concentration of migration in a narrow range of ages) could have been higher than that actually observed.

Appendix. Measurement of the impact of net migration on age distributional change

13. The impact of migration upon population change is direct and indirect. The direct impact of migration is the net addition (or subtraction) to population from in-migration and out-migration. The indirect impact of migration upon population change is the contribution of migration to the number of births and deaths taking place in the relevant areas. Relevant here are the births to in-migrants and to out-migrants after their migration. Also involved are births to non-migrants resulting from their marriages with migrants. Owing to the paucity of suitable data, the indirect impact of net migration upon population can be measured only partially and crudely.

14. When there is no in-migration and no out-migration the net migration is zero, and the natural increase is due solely to the population in the relevant area of the beginning of the migration period. In this situation the expected end-of-period population in the age-group $a + 10$ (for a ten-year migration period) is

$$P(a, 0) \cdot R_a \quad (1),$$

where $P(a, 0)$ is the population aged a at the beginning of the migration period and R_a is the estimated probability of surviving ten years for a person aged a at the beginning of the period. In order to obtain the expected number of survivors among the within-period births to this

hypothetical population, it is assumed that its end-of-period child-woman ratios are approximately the same as those for the observed population, following a technique used by Lee (1957, p. 65).

15. Suppose the comments in the preceding paragraph refer to the first of a sequence of migration periods. For example from 1851 to 1961 there are 12 decennial censuses demarcating 11 intercensal periods. From the foregoing supposition the survival ratio mentioned above refers to the 1851-61 period, and the hypothetical population refers to 1861. Now this 1861 hypothetical population may in turn be subjected to the 1861-71 survival ratios and to the 1871 child-woman ratios. This process would generate a hypothetical 1871 population, based on the assumption of no direct or indirect impact of migration over the two decades. The process may be applied again to generate hypothetical populations from 1881 to 1961, based on the assumption of no direct or indirect impacts of net migration over the 11 decades from 1851 to 1961. The sequence of hypothetical age distributions so generated provides an approximate picture of the path which the age distributional change would have followed had there been no in-migration or out-migration over the 110 year period.

16. Life-table survival ratios have been used. Generally, the life table survival ratio is estimated from the L_x column of a life table. The earliest Canadian life tables based on a ^xthree-year average of deaths pertains to 1931. The author has estimated survival ratios for Canada for decades prior to 1931-41. The values estimated for Canada are mainly adjustments of the estimates provided by Keyfitz (1950), and the estimation technique has been described in Appendix G of Stone (1967b). The limitations of life table survival ratios have been described elsewhere (Hamilton and Henderson, 1944). The life table survival ratios for periods after 1931 were computed from life tables prepared in the Health and Welfare Division of Dominion Bureau of Statistics. The population data are from the decennial Canadian censuses.

FOOTNOTES

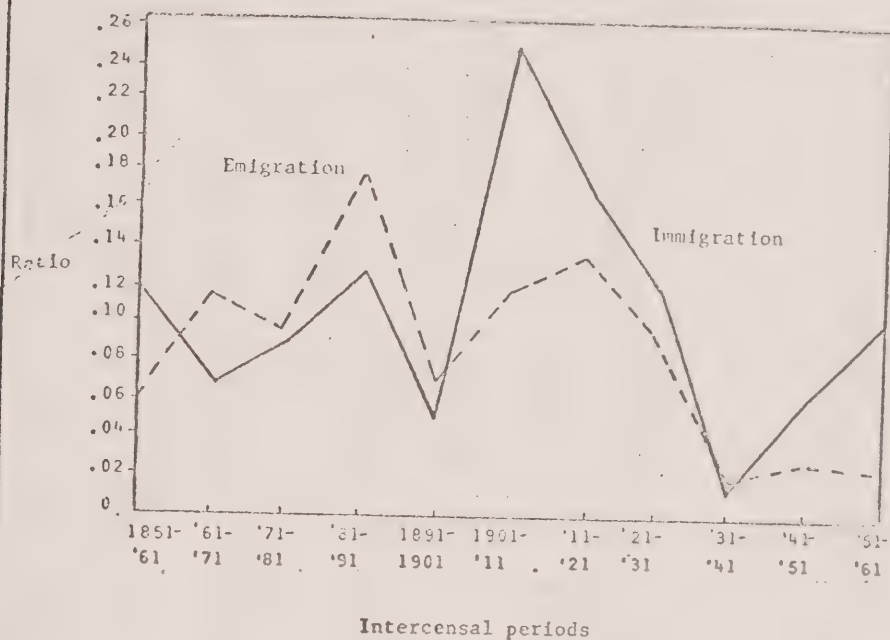
- * Prepared for the 1967 meetings of the International Union for the Scientific Study of Population in Canberra, Australia. The author is solely responsible for any errors or opinions in this paper.
- 1 A population is said to be 'closed' when the designated area which it occupies is neither entered nor left by migration.
 - 2 Let "I" mean the intercensal immigration. Let " P_0 " and " P_1 " be the beginning-of-decade and end-of-decade populations, respectively. The 'relative immigration' mentioned is actually defined as $I / [1/2 (P_0 + P_1)]$. This is the immigration ratio graphed in Chart I.
 - 3 Let "O" mean the intercensal emigration. The relative emigration (emigration ratio) is defined as $O / [1/2 (P_0 + P_1)]$. The net migration ratio is defined as $(I-O) / [1/2 (P_0 + P_1)]$.
 - 4 A sex differential in the quality of census enumeration may also be a factor in the fluctuations mentioned.

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Chart 1. Immigration and emigration ratios,*
Canada, 1851-61 to 1941-61



* Ratio is intercensal immigration (emigration) divided by the mean of the beginning-of-decade and end-of-decade populations.

Data from Camu, Weeks and Sametz, 1964, Table 3.1

TABLE 1. Selected Statistics of the Sex-Age Composition for Observed and Hypothetical* Populations, Canada, 1851-1961

Statistics	1851	1861	1871	1881	1891	1901	1911	1921	1931	1941	1951	1961
Masc. ratio(1), all ages	OP(2)	105.4	105.7	102.7	102.5	103.6	103.0	112.9	106.4	107.5	105.3	102.4
	EP(2)	105.4	105.0	104.8	103.6	102.9	102.4	102.1	101.8	101.7	101.3	100.9
Masc. ratio, 20-34	OP	102.9	103.8	96.8	92.8	101.7	104.5	125.6	103.4	106.6	102.4	96.4
	EP	102.9	101.1	104.7	104.7	103.7	102.5	102.3	102.1	102.0	101.6	101.2
Med. age(3) males	OP	17.5	18.5	18.7	20.0	21.5	22.9	24.5	24.7	25.5	27.5	27.9
	EP	17.5	18.3	19.3	20.3	21.6	22.8	23.5	24.0	24.8	27.0	27.4
Med. age, females	OP	17.0	18.0	18.8	20.0	21.3	22.4	22.9	23.2	24.1	26.6	27.7
	EP	17.0	18.0	19.1	20.1	21.6	22.8	23.6	24.0	24.9	27.2	28.0
Youth dep. ratio(4)	OP	85.8	78.0	76.0	67.7	61.8	57.3	53.0	56.7	50.4	42.4	48.5
	EP	85.8	80.4	73.8	65.1	60.5	56.7	55.8	56.5	50.6	42.6	47.8
Old age dep. ratio(5)	OP	5.1	5.6	6.7	7.2	7.8	8.4	7.5	7.8	8.8	10.2	12.5
	EP	5.1	4.9	5.3	5.4	5.7	6.4	7.2	8.6	10.2	10.8	11.8

* This is the hypothetically 'closed' population mentioned in the Appendix. The figures for this population, see the rows marked "EP", are estimates of features of the age distribution which would have been observed had there been no migration into or from Canada between 1851 and 1961.

(1) Masculinity ratio = 100 (Males/Females)

(2) "OP" means census population

"EP" means hypothetically closed population

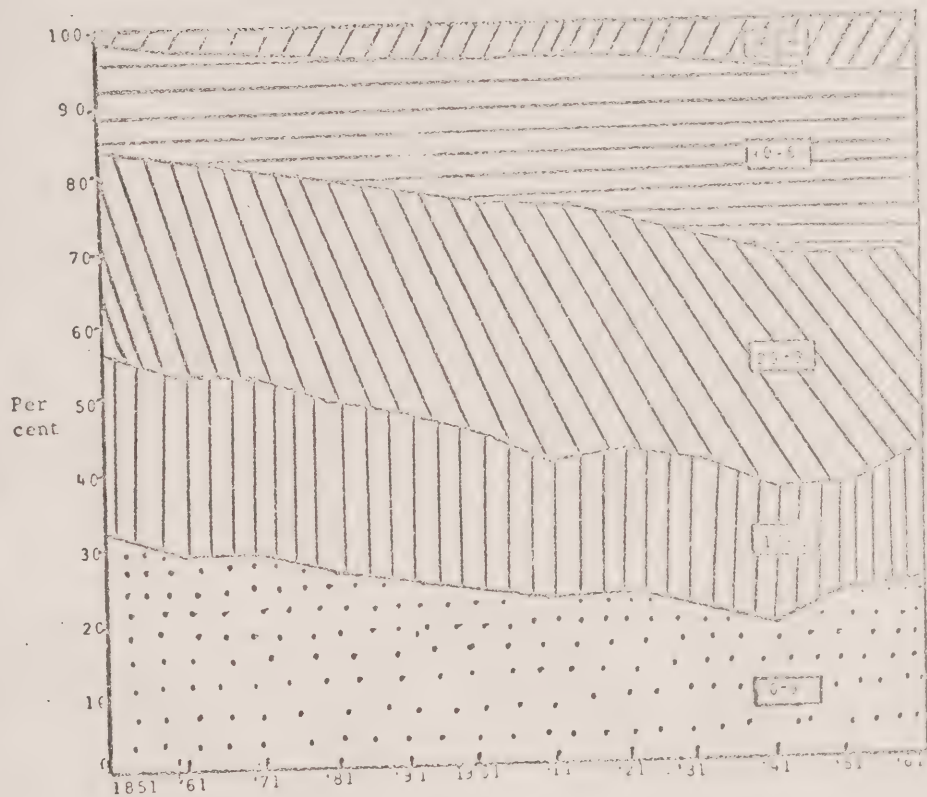
(3) Median age

(4) Youth dependency ratio = 100 (Population aged 0-14/Population aged 15-64)

(5) Old age dependency ratio = 100 (Population aged 65 & over/Population aged 15-64)

Source: Censuses of Canada; life tables published in Canadian Life Tables (prepared in the Health and Welfare Division of Dominion Bureau of Statistics); and Keyfitz (1950).

Chart 2. Changes in the age distribution for
males, Canada, 1851-1961
(observed population)



Legend:-



0-9



10-19



20-39



40-64

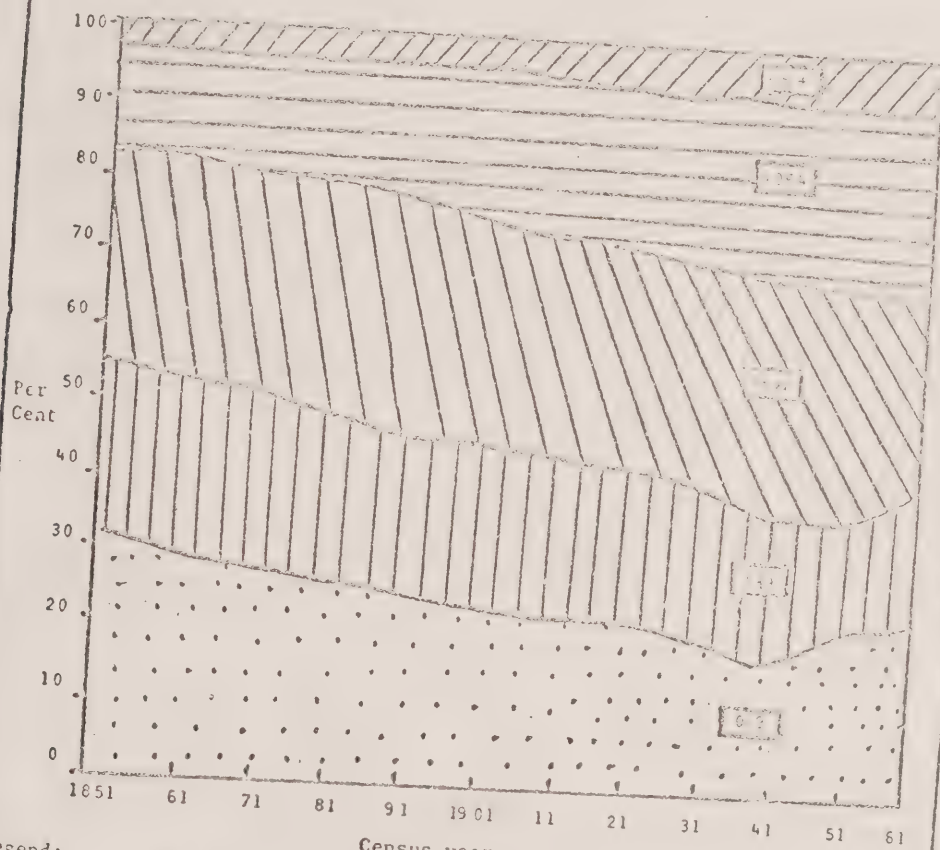


65+

Data from Census of Canada

Chart 2 (Cont'd.)

(Hypothetical 'closed' population)



Legend:-



0-9



40-64



10-19



65 + over



20-39

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